DE OS 34 47 079

Carl Still GmbH & Co. KG

Process for the thermal treatment of contaminated soil

<u>Claims</u>

1. Process for the thermal treatment of contaminated soil, the soil being contaminated with products generated especially in the coking of coal, such as eg. tarry, phenolic and oily constituents and heavy hydrocarbons, c h a r a c t e r i s e d i n that the contaminated soil is thermally treated by indirect heating and/or by direct addition of hot waste gases and/or air with partial combustion of the decomposition products as well as the C_{fix} from the soil and in that the resulting production gas is burnt afterwards at high temperatures to destroy any toxic components which may have been generated.

2. Process according to claim 1, c h a r a c t e r i s e d i n that sludge coal or other fuels are admixed with the contaminated soil.

3. Process according to claims 1 or 2, c h a r a c t e r i s e d i n that the thermal treatment takes place at about 600 to 800°C.

4. Process according to at least one of claims 1 to 3, c h a r a c t e r i s e d i n that the post-combustion takes place at temperatures of at least 1000°C, preferably 1100 - 1200°C.

5. Process according to at least one of claims 1 to 4, c h a r a c t e r i s e d i n that the ashes generated during post-combustion are removed in dry or liquid form, depending on their softening point.

6. Process according to at least one of claims 1 to 5, c h a r a c t e r i s e d i n that the time the gases remain in the combustion chamber during post-combustion is controlled as a function of the temperature, in inverse proportion thereto.

7. Process according to at least one of claims 1 to 6, c h a r a c t e r i s e d i n that the post-combustion is carried out in several stages.

8. Process according to at least one of claims 1 to 7, characterised in that the post-combustion waste gases are cooled to about 200 to 400°C in a heat exchanger and/or by adding cooling air and are released into the atmosphere after dust removal or filtration.

9. Process according to at least one of claims 1 to 8, characterised in that the composition of gas at the post-combustion temperature is maintained as constant as possible by abrupt cooling, for example by means of a liquid medium.

10. Process according to at least one of claims 1 to 9, characterised in that the thermally treated soil and/or sludge coal are removed at a temperature of 700°C and are cooled in a coiled cooling pipe, for example by injecting water.

11. Process according to at least one of claims 1 to 10, characterised in that the production gas is burnt afterwards with addition of eg. liquid gas as supporting gas and the required temperature during post-combustion is maintained by adjusting the amount of supporting gas.

12. Process according to at least one of claims 1 to 11, characterised in that the contaminated soil and/or sludge coal are thermally treated in a rotary kiln in parallel or counterflow to the hot gases or air.

13. Process according to at least one of claims 1 to 12, characterised in that the products used are mixed prior to being fed into the rotary kiln and are crushed in order to achieve as even a grain size range as possible.

14. Process according to at least one of claims 1 to 13, characterised in that the contaminated soil and/or sludge coal are pre-dried before being fed into the rotary kiln, preferably to a water content of less than 10%.

15. Process according to at least claim 14, characterised in that, after pre-drying, the iron pollutants are removed from the soil, for example by means of a magnetic grate, and in that any oversized grains are also screened out before the soil is fed into the rotary kiln.

16. Process according to at least claim 14, characterised in that the post-combustion waste gases are wholly or partially used in parallel or counterflow for direct pre-drying.

17. Process according to claim 1, characterised in that the heating gases are used first for indirect heating and are subsequently used wholly or partially for direct heating, in parallel or counterflow, possibly with added air and/or additional gases.

18. Installation for carrying out the process according to claim 1, characterised in that a central, preferably cooled tube having orifices (31) distributed over its entire length is arranged inside rotary kiln (105) for the separate supply of air and/or additional combustion gas.

19. Installation according to claim 18, characterised in that central tube (28) has a protective jacket (32) made of refractory material.

20. Installation according to claim 18, characterised in that supply means for the combustion media are provided at both ends of tube (28).

21. Installation for carrying out the process according to claims 1 or 17, characterised in that the rotary kiln consists of a stationary outer jacket chamber (46) for indirect heating of the inner rotary tube, the rotary tube being made of metal and the outer wall of jacket chamber (46) being lined with refractory material (233).

22. Installation according to claim 21, characterised in that, in the case of combined heating, waste gas exit line (50) of outer jacket chamber (46) is connected to the feed side of the inner rotary tube.

Description

The present invention relates to a process for the thermal treatment of contaminated soil, the soil being contaminated with products which are generated especially in the coking of coal, such as for example tarry, phenolic and oily constituents and heavy hydrocarbons.

Contaminated soil is understood to be soil polluted with all possible products from the coking process. This soil varies in appearance from reddish brown to black and usually emits an unpleasant smell. To date, no process for treating such contaminated soil is known, other than that this soil had to be removed and stored in special dumps.

It is the object of the present invention to provide an effective process for treating this contaminated soil.

This object according to the invention is achieved in that the contaminated soil is thermally treated by direct addition of hot combustion gases and/or air with the partial combustion of the decomposition products as well as the C_{fix} from the soil, and/or by indirect heating, and in that the resulting production gas is burnt afterwards at high temperatures in order to destroy any toxic components which may have been generated.

The proposed invention makes it possible to completely remove all toxic and eg. foul-smelling constituents from the contaminated soil so that it no longer causes environmental damage. The production gas generated by the thermal treatment may still contain toxic components which are decomposed again by the post-combustion at high temperatures which immediately follows the thermal treatment.

According to the invention, it has proved to be advantageous when sludge coal or other fuels are mixed into the contaminated soil. This results in the proportion of solid fuels being increased, so that very little additional gas needs to be added for the thermal treatment of the contaminated soil. Liquid gas is fed in only to start and heat up the installation. The proportion of sludge coal in the material fed in for thermal treatment may be about 5 to 20%.

According to the invention, the thermal treatment is carried out at about 600 to 800°C. These temperatures have proved sufficient to completely remove pollutants from the contaminated soil. The post-combustion is intended to take place at temperatures of at least

1000°C, preferably 1100 - 1200°C. This temperature of at least 1000°C is necessary to destroy all toxic components, which may include dioxin.

According to the invention, the ashes generated during post-combustion are removed in dry or liquid form, depending on their softening point. Especially for the removal of liquid ashes it has proved to be efficient to design the post-combustion chamber perpendicularly or with an inclination declining in the direction of flow of the gases. The liquid slag is sluiced out at the lowest point, while the gases are drawn off in upward direction.

It has proved that the duration of post-combustion at very high temperatures can be shorter than at lower temperatures. Therefore, according to the invention, the duration is controlled inversely proportional to the temperature.

It is also possible, according to the invention, to carry out the post-combustion in several stages. This is particularly advantageous with a view to reducing the production of any NOX.

The post-combustion waste gases are preferably cooled to about 200 - 400°C in a heat exchanger and/or by admixing cooling air, and are released into the atmosphere after removal of dust or filtration. At the temperatures indicated it is possible to install a simple extractor downstream of the post-combustion stage, and there are no temperature problems for the design of the dust removal or filter installations.

In order to avoid any re-formation of noxious or toxic gases, it has proved to be advantageous when the gas composition prevailing at the post-combustion temperature is held as constant as possible by abrupt cooling, for example by means of a liquid medium.

The thermally treated soil and/or sludge coal can be removed at a temperature of approximately 700°C and be further cooled in a coiled cooling pipe eg. by injecting water before it is removed for further processing.

In order to ensure an even post-combustion of the production gas which fluctuates in caloric value, it is possible to feed in eg. liquid gas as a supporting gas and to maintain the required temperature during post-combustion by controlling the amount of supporting gas.

The contaminated soil or sludge coal is advantageously thermally treated in a rotary kiln in parallel or counterflow to the hot gases. Furthermore, the feed products can be mixed

before being fed into the rotary kiln and be broken up in order to achieve an optimally uniform grain size range.

As the composition of the contaminated soil often varies, especially as to water content, and may contain large clumps of soil containing foreign bodies such as bricks and bits of iron, the invention provides that the contaminated soil and/or the sludge coal is pre-dried preferably to a water content of less than 10% before being fed into the bricklined kiln. Then the iron bits are effectively separated from the soil, for example by means of a magnetic grate. Any oversized pieces and larger stones may also be screened out.

According to the invention, the post-combustion waste gases may be used wholly or partially, in parallel or counterflow, for pre-drying. An unlined rotary tube has proved to be a robust device for this purpose.

The use of the post-combustion waste gas heat to preheat and dry the soil is advantageous with a view to the comminution of the viscous and lumpy raw material. In addition, pre-drying substantially reduces the load on the downstream installation.

In case indirect heating is combined with direct heating of the contaminated soil in the rotary kiln, it is particularly advantageous if the heating gases are first used for indirect heating and then wholly or partially for direct heating, possibly with the addition of air and/or additional gases, in parallel or counterflow. By adding further combustion air in the recycled hot waste gas stream, a partial combustion of the decomposition products released by the thermal treatment as well as the C_{fix} proportion of the soil takes place in the rotary kiln.

Compared to a rotary kiln which is only heated directly, the combination provides the advantage that, due to the lower gas velocity in the rotary kiln, smaller quantities of dust are released and introduced into the waste gas combustion chamber. As a result of recycling the hot waste gases generated by the combustion of liquid gas and emerging from the combustion chamber of the rotary kiln at about 850°C, the thermal efficiency is also improved compared to a rotary kiln which is only indirectly heated. Furthermore, recycling of the waste gas provides advantages in starting up the installation. In addition, the combined heating offers high flexibility and possible adjustment to the varying degrees of contamination of the soil to be treated.

In order to carry out the process according to the invention, it is proposed that a prior art rotary kiln is used for the thermal treatment, with an additional central, preferably cooled tube having orifices distributed over its entire length and being arranged inside the rotary kiln for the separate supply of air and/or the additional combustion gas. The central tube may also have a protective jacket made of refractory material and the media are fed in from both tube ends. In order to carry out the combined heating, the rotary kiln consists, according to the invention, of a stationary outer jacket chamber for the indirect heating of the inner rotary tube, said tube being made of metal and the outer wall of the jacket chamber being lined with refractory material. It is advantageous if the waste gas discharge line of the outer jacket chamber is connected to the inlet side of the inner rotary tube.

In order to explain the invention, an exemplified embodiment is given below.

Exemplified embodiment:

Approximately 7000 kg of contaminated soil having the following composition:

water content	approx. 21.0 %
ashes	approx. 69.6 %
volatiles	approx. 4.7 %
C_{fix}	approx. 4.7 %
bulk weight, dry	approx. 1100 kg/m^3

and approximately 500 kg of sludge coal having the following composition:

water content	approx. 10.0 %
ashes	approx. 10.0 %
volatiles	approx. 30.0 %
C_{fix}	approx. 50.0 %
bulk weight	approx. 750 kg/m^3

are fed per hour into a crusher where they are crushed and mixed and are subsequently thermally treated in a rotary kiln at temperatures ranging from 700 to 800°C. At a

temperature of about 700°C, approximately 5,700 kg of purified soil having the following composition:

water content	approx. 8.0 %
ashes	approx. 86.3 %
volatiles	approx. 1.5 %
C_{fix}	approx. 4.2 %
bulk weight, dry	approx. 1000 kg/m^3

are removed per hour from the rotary kiln and subsequently cooled with water.

The invention is explained in greater detail with reference to the accompanying figures 1 to 5.

Figure 1	shows a rotary kiln according to the invention in parallel flow.
Figure 2	shows a rotary kiln installation in counterflow.
Figure 3	shows the pre-drying installation to complement Fig. 2.
Figure 4	shows a cross-section through the rotary tube.
Figure 5	shows, similar to Fig. 2, a complete installation with combined heating of the rotary kiln.

Contaminated soil (1) and sludge coal (2) are fed via conveyor means into crusher (3) and moved via feed device (4) into rotary kiln (5). The rotary kiln (5) or (105) has a support structure (6) at each end. In order to heat up rotary kiln (5), (105), liquid gas is supplied through line (8), (108) and check valve (10), (110) into burner (7), (107). The air is supplied to rotary kiln (5), (105) by means of air compressor (9), (109) through check valves (11), (12), (111).

In Figure 1, the production gas is removed in parallel flow at the opposite end of the rotary kiln via line (15) and is fed directly into waste gas combustion chamber (22) where, with the addition of air from the line with check valve (14) and liquid gas from the line with check valve (13), post-combustion of the production gas takes place. After combustion the combustion gas is cooled to about 200 to 400°C with cooling air which is supplied at (21) and is removed from the system through extractor (23). On the same side where the

production gas is removed, the thermally treated soil is also removed in parallel flow, according to Figure 1, via line (16) and is subsequently sprayed with water from connections (18) in coiled cooling pipe (17) which is driven by motor (19). The product can then be moved on via conveyor belt 20 for further treatment.

In Figure 2 the rotary kiln is shown for counterflow operation. In this case, burner (107) with feed pipes (108 - 111) for liquid gas and air is located at the opposite end from that where contaminated soil and sludge coal are fed in. The production gas is partially recycled via line (27) by means of fan (26) to burner (107), and the remainder is moved via line (115) into post-combustion chamber (22). The solid product is removed in the usual manner at the same side as that where the burner is located. Figure 2 also shows a heat exchanger (24) in combustion chamber (22) in which the waste gases are used for heating, for example, service water for generating steam. Before the combustion waste gases are released into the atmosphere, residual solid particles are removed in a filter installation, for example in an electrofilter (25) or in a bag filter.

Figures 2 to 4 show an additional central tube (28) represented in broken lines inside rotary kiln (105) in which orifices (31) are provided oriented radially outwards from the centre into rotary kiln (105). Figure 4 shows in cross-section the arrangement of individual supply lines (30) inside tube (28), said tube (28) being subdivided by separate radial partitions. Tube (28) is further enclosed by a cooling jacket (29) which in turn has a refractory protective jacket. Likewise, the inside of rotary kiln (105) has a refractory lining (33).

Tube (28) has the particular advantage that the air and the gas can be supplied radially outwards from the centre and over the entire length of rotary kiln (105), and that heating gases can be fed in not only on the side of the burner, but at multiple locations.

Figure 3 shows a particular embodiment of post-combustion chamber (122), wherein the actual combustion chamber is arranged at an angle with a perpendicular shaft connected at its lower end in which the waste gases flow upwards. These gases are cooled in heat exchanger (124) and by the supply of cooling air (121). A portion of the waste gases is released into the atmosphere after a possible further removal of fine dust. The remaining portion is fed into pre-drying installation (37) via line (36) by means of fan (35) and is used to pre-dry the contaminated soil fed in via (38) from which, after leaving pre-drying installation (37), oversized particles (44) are removed on a screen (43) and iron is removed

by means of magnetic grate (42). Via line (101) and feeder (104) the pre-dried soil and the sludge coal are then fed into rotary kiln (105).

Figure 5 shows diagrammatically a complete installation for the thermal treatment of contaminated soil similar to Figure 2. The main difference from the diagram of Figure 2 is that the actual rotary kiln (205) for the thermal treatment of contaminated soil is enclosed by a stationary outer jacket chamber (46) for the indirect heating of the inner rotary tube. A plurality of burners (207) is arranged at regular intervals over the length of the rotary tube, whose wall is made of metal. Burners (207) are supplied with air by means of fan (209) and with liquid gas via line (208). By means of suitable built-in components in jacket chamber (46), the heat from the waste gases is given off evenly to rotary kiln (205) and above the rotary kiln the waste gases are moved evenly distributed by means of throttle valves (47) into a gas collection chamber (48). The major portion of the combustion waste gases is fed from collection chamber (48) at a temperature of about 800 to 850°C on the feed side of the contaminated soil into the interior of rotary kiln (205) and is used for direct heating to a temperature of about 700°C of the soil which had already been heated to 80 to 120°C in pre-drying installation (37 a). A portion of the waste gases is fed from collection chamber (48) together with the production gas from the inner rotary kiln via line (215) to waste gas combustion chamber (222). The amount of hot waste gases removed via line (249) is controlled as a function of the temperature of the contaminated soil reached upon leaving rotary kiln (205).

Another difference of the diagram of Figure 5 from the diagram of Figure 2 is that the waste gases from post-combustion chamber (222) are used to pre-dry the soil in parallel flow in pre-drying installation (37 a). To this end, the waste gases from post-combustion chamber (222) are fed via line (36) and (36 a) to the point where contaminated soil is fed into pre-drying installation (37 a) and are removed again at the outlet end of the pre-dried soil via line (39 a) and are released into the atmosphere via bag filter device (40) and extractor (35 a). The pre-drying installation and filter installation must be operated in vacuum. This has the particular advantage that there are no sealing and emission problems in pre-drying installation (37 a) which is designed as a rotary tube. The waste gases from post-combustion chamber (222) which have a temperature of about 200°C are supplied via line (45) with an adjustable amount of cooling air or water, so that both the temperature of

the soil removed from the pre-drying installation and the temperature of the waste gases fed to the bag filter can be controlled. The temperature of the contaminated soil upon leaving the pre-drying installation is kept so low, at 80 to 120°C, that no tarry constituents can escape with the gas. On the other hand, a certain maximum temperature of the waste gases is required by the use of a bag filter installation.

List of reference numerals

(1), (101)	Contaminated soil
(2)	Sludge coal
(3)	Crusher
(4), (104)	Feeder
(5), (105), (205)	Rotary kiln
(6)	Rotary kiln support structure
(7), (107), (207)	Burner
(8), (108), (208)	Liquid gas supply
(9), (109), (209)	Air compressor
(10) - (14)	Check valves
(110) - (113)	Check valves
(15), (115), (215)	Production gas lines
(16)	Thermally treated soil
(17)	Coiled cooling pipe
(18)	Water supply
(19)	Drive motor for (17)
(20), (121)	Cooling air
(22), (122), (222)	Waste gas combustion chamber
(23)	Extractor
(24), (124)	Heat exchanger
(25)	Electrofilter
(26), (126)	Fan
(27), (27 a)	Production gas line
(28)	Central tube

(29)	Cooling jacket
(30)	Supply line
(31)	Orifices
(32)	Refractory protective jacket
(33), (233)	Refractory lining
(34), (34 a)	Slag removal
(35), (35 a)	Extractor
(36), (36 a)	Recycling line
(37), (37 a)	Pre-drying installation
(38)	Contaminated soil
(39), (39 a)	Vapour removal
(40)	Dust removal
(41)	Pre-dried soil
(42)	Magnetic grate
(43)	Screen
(44)	Oversized grains
(45)	Air
(46)	Jacket chamber
(47)	Throttle valves for indirect heating
(48)	Collecting chamber
(49)	Waste gas removal
(50)	Waste gas line
(51)	Wet slag removal

Nummer: 34 47 079
Int. Cl.⁴: A 62 D 3/00
Anmeldetag: 22. Dezember 1984
Offenlegungstag: 6. März 1986

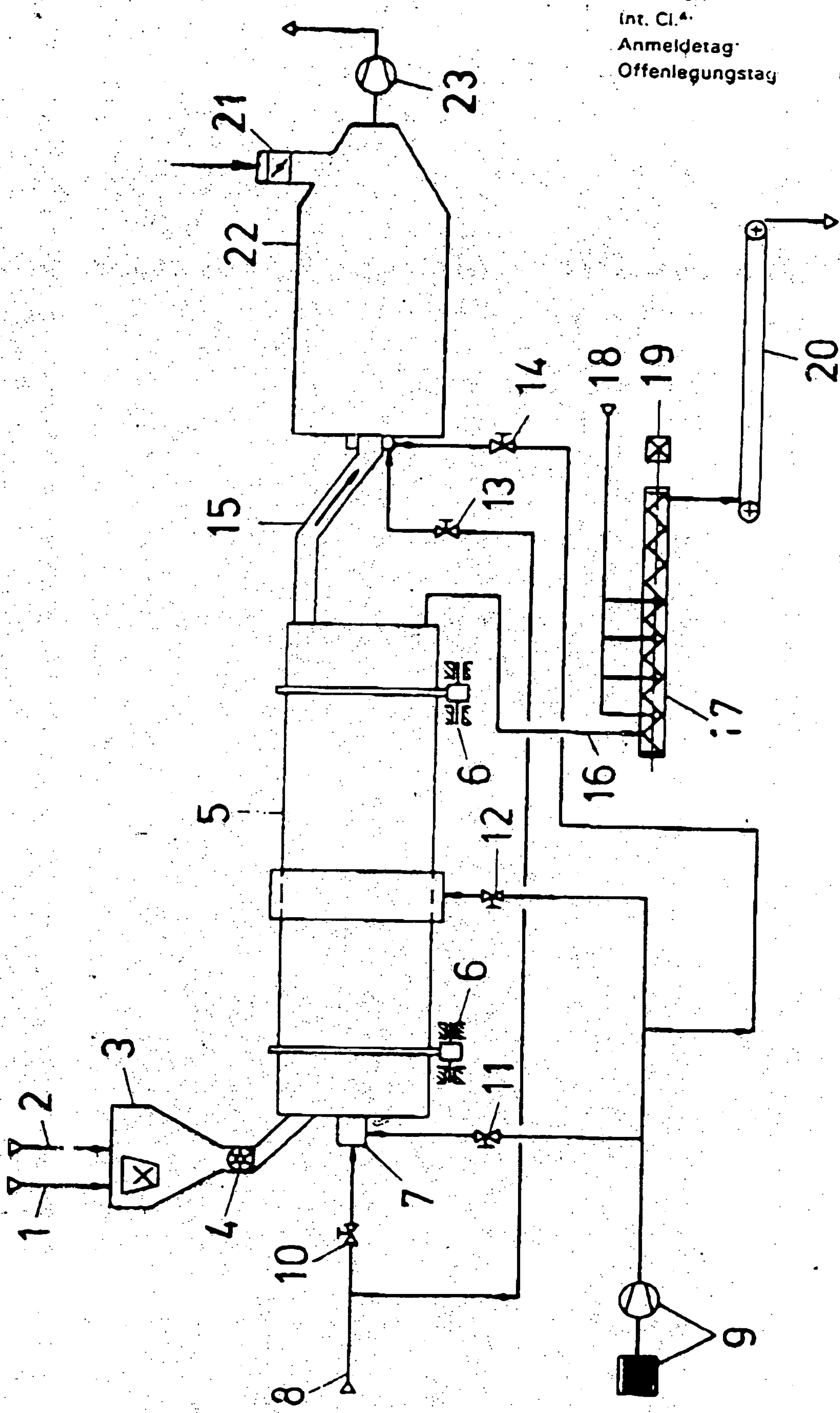
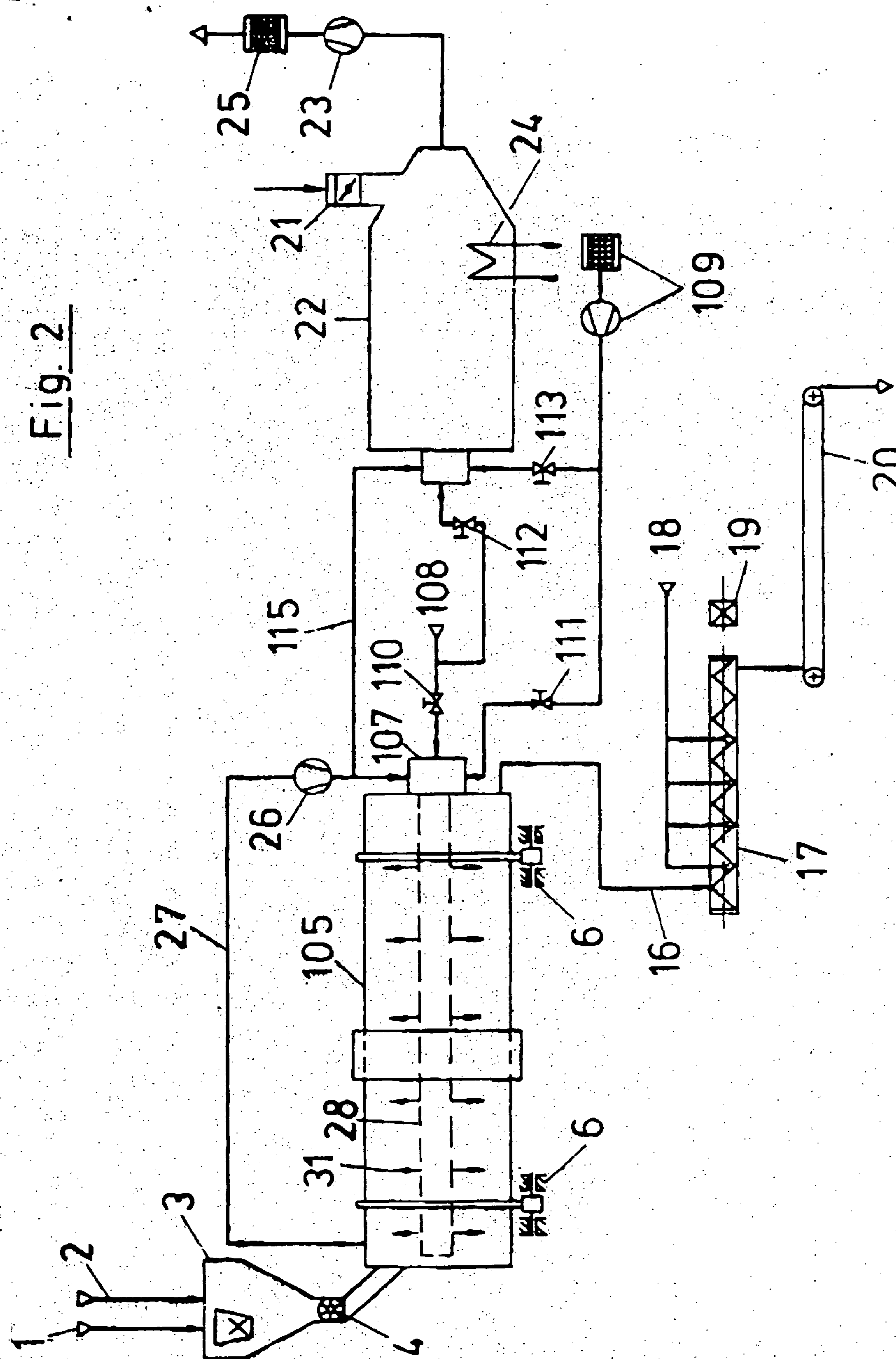


Fig. 1

3447079

Fig. 2



Received Time 8. Apr. 12:00

3447079

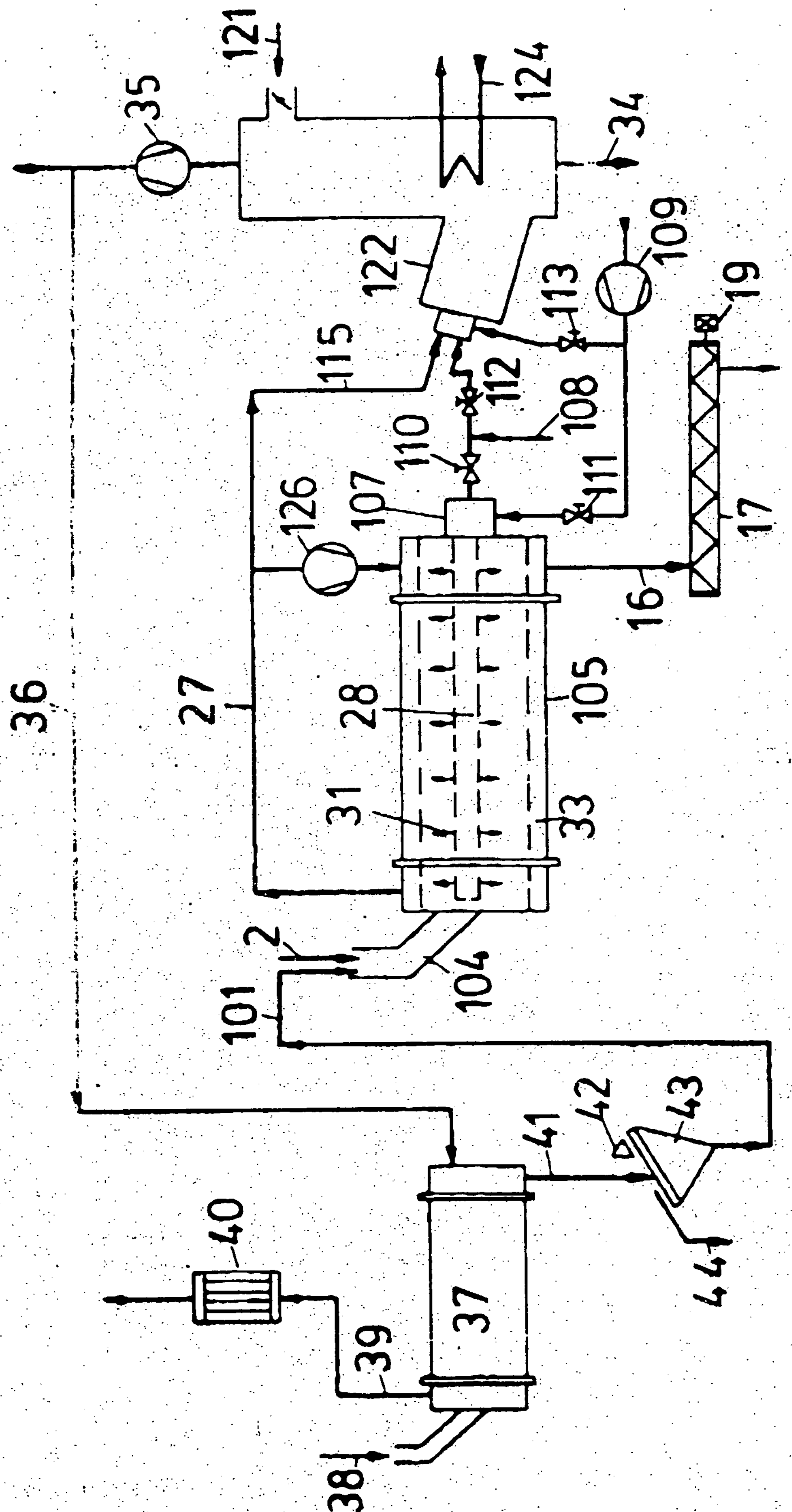


Fig. 3

Received Time 8. Apr. 12:00

3447079

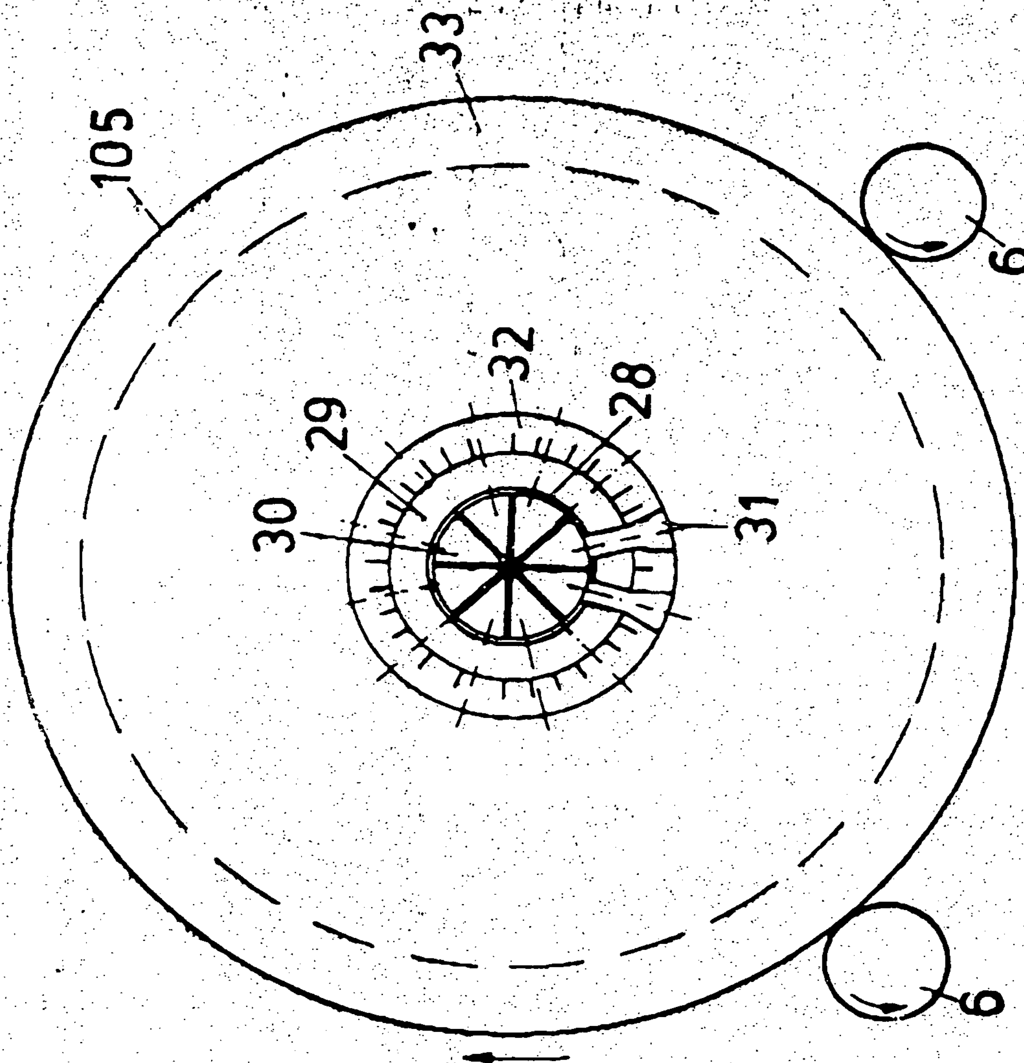


Fig. 4

3447079

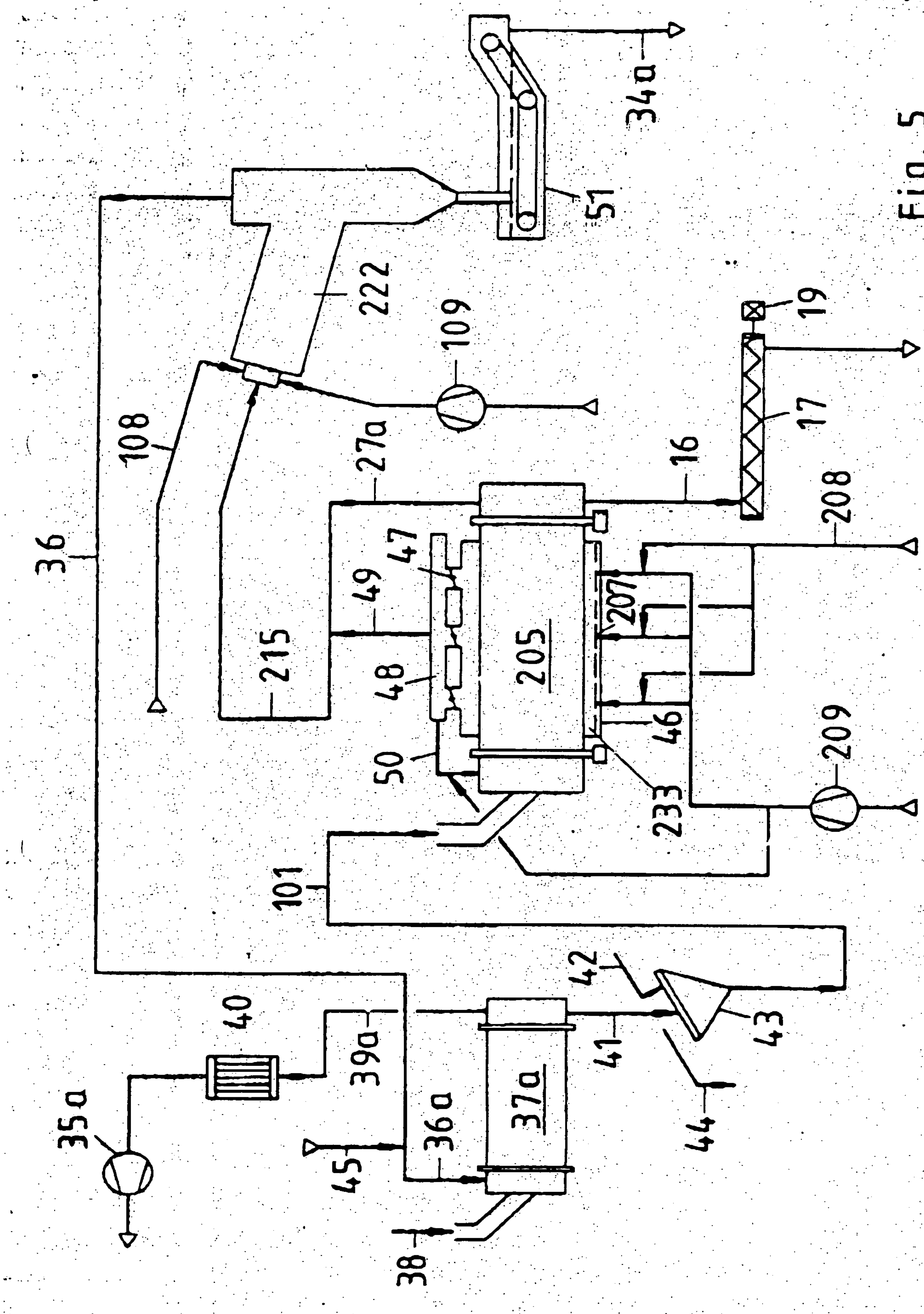


Fig. 5